

PATENT

ATTORNEY DOCKET NO. ACBI.049.00US

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: Sam Schaeviz *et al*

) Examiner: Not Yet Assigned

Serial No.: Not Yet Assigned

) Art Unit: Not Yet Assigned

Filed: 18 October 2000

) UTILITY PATENT APPLICATION

For: Efficient microfluidic sealing

) TRANSMITTAL

**BOX PATENT APPLICATION**

Director of Patents and Trademarks  
Washington, D.C. 20231

Sir:

This is a request for filing a patent application under 37 C.F.R. § 1.53(b) in the name of inventors: Sam Schaeviz, Travis Boone, Torleif Ove Bjornson

For: Efficient microfluidic sealing

This application claims priority of U.S. Patent Provisional Application Serial No. 09/545,064 filed on October 22, 1999 under 35 U.S.C. § 119(e).

Application Elements:

- 11 Pages of Specification, Claims and Abstract
- 3 Sheet of formal Drawings

CERTIFICATE OF EXPRESS MAILING

"Express Mail" Label No. EL637194076US

Date of Deposit: 10-18-00

I hereby certify under 37 C.F.R. 1.10 that this correspondence is being deposited with the United States Postal Service as "Express Mail Post Office to Addressee" with sufficient postage on the date indicated above and is addressed to BOX PATENT APPLICATION, Commissioner of Patents and Trademarks, Washington, D.C., 20231.

(Signature)

(Printed Name)

*Francis Guerra*  
Francis Guerra

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jc950 U.S. PTO

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jc860 U.S. PTO  
09/691957  
10/18/00

09545064 10/20/00

- ☒ Declaration
- ☒ Unexecuted Combined Inventor Declaration and Power of Attorney
- ☐ Copy from prior application (37 CFR 1.63(d) for a continuation or divisional).
- The entire disclosure of the prior application from which a copy of the declaration is herein supplied is considered as being part of the disclosure of the accompanying application and is hereby incorporated by reference therein.
- ☐ Deletion of inventors Signed statement attached deleting inventor(s) named in the prior application, *see* CFR 1.63(d)(2) and 1.33(b).

Accompanying Application Parts:

- ☐ Assignment and Assignment Recordation Cover Sheet (recording fee of \$40.00 enclosed)
- ☐ Power of Attorney
- ☐ 37 CFR 3.73(b) Statement by Assignee
- ☐ Information Disclosure Statement with Form 1449
- ☐ Copies of IDS Citations
- ☐ Preliminary Amendment
- ☒ Return Receipt Postcard
- ☒ Small Entity Statement(s) ☒ Statement filed in prior application.  
Status still proper and desired.
- ☐ Other:
- ☐ A sequence listing.
- ☐ paper copy.
- ☐ computer readable copy.
- ☐ Statement in Compliance with Requirements for Patent Applications Containing Nucleotide and/or Amino Acid Sequence.

Claim For Foreign Priority

- ☐ Priority of \_\_\_\_\_ Application No. \_\_\_\_\_ filed on \_\_\_\_\_  
is claimed under 35 U.S.C. § 119
- ☐ The certified copy has been filed in prior application U.S. Application No. \_\_\_\_\_
- ☐ the certified copy will follow.

Extension of Time for Prior Pending Application

- ☐ A Petition for Extension of Time is being concurrently filed in the prior pending application. A copy of the Petition for Extension of Time is attached.

# Amendments

- ☐ Amend the specification by inserting before the first line the sentence: "This is a  
☐ Continuation ☐ Continuation-in-part ☐ Nonprovisional application of  
copending prior  
☐ Application Serial No. 60/153,644 filed on September 13, 1999.  
☐ International Application \_\_\_\_\_ filed on \_\_\_\_\_, which  
designated the United States, disclosure of which is incorporated herein by reference."  
☐ Cancel in this application original claims \_\_\_\_\_ of the prior application before  
calculating the filing fee

## Fee Calculation (37 CFR § 1.16):

	(Col. 1)	(Col. 2)	OTHER THAN A			
			<u>SMALL</u>			
			<u>ENTITY</u>			
<u>FOR:</u>	<u>NO. FILED</u>	<u>NO.</u>	<u>RATE</u>	<u>FEE</u>	<u>RATE</u>	<u>FEE</u>
		<u>EXTRA</u>				
Basic Fee			\$355	\$355	\$690	\$
Total Claims	14		\$ 9	\$	\$ 18	\$
Indep. Claims	3		\$ 39	\$	\$ 78	\$
<input type="checkbox"/> Multiple Dep. Claims			\$130	\$0	\$260	\$
Total Filing Fee:				<b>\$355</b>		

**TOTAL FEES: \$355.00**

- ☒ A check including the amount of **\$355.00** is attached.  
☐ Please charge Deposit Account No.18-0020 in the amount of \$.  
☐ No fee is required.

- [X] Conditional Petition for Extension of Time: An extension of time is requested in the present and/or the above-referenced parent application to provide for timely filing if an extension of time is still required after all papers filed with this transmittal have been considered.
- [X] The Commissioner is hereby authorized to charge any underpayment of the following fees associated with this communication, including any necessary fees for extension of time, or credit any overpayment to Deposit Account No. 18-0020.
- [X] Any filing fees under 37 CFR 1.16 including fees for the presentation of extra claims.
- [X] Any parent application processing fees under 37 CFR 1.17.
- [X] A **duplicate** copy of this sheet is attached for accounting purposes.

Respectfully submitted,

Dated: October 18, 2000

By: Barbara Rae-Venter  
Barbara Rae-Venter, Ph.D.  
Reg. No. 32,750

Rae-Venter Law Group, P.C.  
P.O. Box 60039  
Palo Alto, California 94306  
Telephone: (650) 328-4400  
Facsimile: (650) 328-4477

BRV/jea  
Enclosures

**APPLICATION**

**FOR**

**UNITED STATES LETTERS PATENT**

**TITLE: EFFICIENT MICROFLUIDIC SEALING**

**INVENTORS: SAM SCHAEVITZ, TRAVIS BOONE,  
TORLIEF OVE BJORNSON**

**CERTIFICATE OF EXPRESS MAILING**

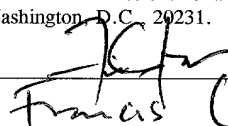
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(Signature)

(Printed Name)

  
Francis Guerra

## EFFICIENT MICROFLUIDIC SEALING

### CROSS-REFERENCE TO RELATED APPLICATIONS

5           This application claims the benefit of the filing date of U.S. provisional application 09/545,064 filed October 22, 2000, which disclosure is hereby incorporated by reference.

### INTRODUCTION

#### Field of the Invention

10           The field of this invention is microfluidic devices.

#### Background

15           Microfluidic devices offer great promise for the accurate manipulation of very small volumes, the rapid execution of a wide variety of operations, the minimal use of reagents, as well as many other benefits. As with all situations, the benefits come with challenges. For many purposes, one wishes to have a number of independent electrokinetic units in a single substrate. Since each unit will frequently comprise a plurality of reservoirs and channels, it is  
20           important that the individual units do not communicate except as required by the design of the device. Also importantly, is the problem of the very small volumes, which are frequently involved with the operations, due to evaporation. Where there is an interest in doing a quantitative analysis of an operation involving kinetics, it is important that the solvent volume remain substantially constant, so that the concentrations of the reactants are not changing due to  
25           decreasing volume. To this end, methods are required to minimize evaporation. Additionally, particularly where long incubation times and/or long reaction times are involved, there is an interest in preventing contamination. A further concern is adventitious pressurization, during closing of a microstructure vessel, which could prematurely move the liquid from a reservoir into a channel.

30           In response to these concerns, lids have been used to seal the ports of microfluidic devices. Lids may provide sealing through the pressure of their weight, by providing adhesion, using various forms of latches or clasps, or by fitting snugly around a part and held by friction.

There is an interest in developing devices and methods to substantially diminish the injurious events that may occur due to open ports of a microfluidic device, where the devices are effective and can be readily fabricated and methods readily performed.

5 Relevant Art

U.S. Patent no. 5,444,890 and references cited therein describe leakage-proof sealing of microfluidic devices. WO99/43432 describes microfluidic devices and systems incorporating cover layers. U.S. Patent no. 5,545,280 describes applying adhesive to protrusions on a substrate.

10 SUMMARY OF THE INVENTION

Improved microfluidic devices are provided for use in performing operations involving the manipulation of small volumes. Substrates are formed comprising channels and reservoirs, where the channels communicate with the reservoirs and the channels are otherwise enclosed, and the reservoirs have an aligned collar in relief, extending beyond the planar surface of the substrate and outwardly from the border of the reservoir. The reservoirs are more efficiently sealed with an appropriate cover which contacts the crown of the collar. The substrates may be formed by plastic molding or other means. Of particular interest are devices employing electrokinesis for movement of solutions from one site to another in the device, where the substrate comprises a plurality of individual electrokinetic units and the volumes involved generally are below about 5 $\mu$ l.

25 BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a plan view of a device with collars around microstructures; Fig. 1a is a cross-sectional view of the device of Fig. 1 along lines 1a-1a;

Fig. 2 is a plan view of the device of Fig. 1, with the collars removed to provide details of the individual units; Fig. 2a is a diagrammatic exploded view of the units of Fig. 2;

30 Fig. 3 is a side elevation cross-sectional view of a reservoir microstructure of a unit with a cover.

### DESCRIPTION OF THE SPECIFIC EMBODIMENTS

The following examples are offered by way of illustration of the present invention, not  
5 limitation. Microfluidic devices are provided for manipulation of small volumes, where the  
devices comprise a substrate, usually an organic substrate in which are channels and reservoirs,  
where the reservoirs have a raised collar above the planar surface of the substrate. A bottom  
film, including a rigid substrate, is adhered to and encloses the channels and the bottoms of the  
reservoirs. The reservoirs can be sealed on the top side using a film, which seals to the upper  
10 surface of the collar.

The microfluidic devices will be characterized by having one or more operational units  
present in the substrate, where the number of units may vary from 16 to 1536 units, more usually  
not more than about 384 units, the number of units frequently being related to the number of  
wells in a microtiter well plate. Each unit will have at least one channel and at least two  
15 reservoirs, usually having at least two channels and at least four reservoirs. The total number of  
reservoirs for a device will generally be in the range of about 4 to 1600, more usually in the  
range of about 64 to 1500.

The sealing cover or lid will be a film, which forms a seal about the collar, so as to at  
least substantially inhibit fluid flow from the reservoir. The cover will provide for sealing  
20 interaction with the collar upper surface, as a result of a compliant surface contacting the collar  
or an adhesive surface adhering to the upper surface of the collar, particularly an adhesive  
surface, which is removable. Contact will usually be minimal or not at all between the sealing  
cover or lid and the planar surface. The forces providing the sealing may be gravity, adhesive  
forces, or mechanical forces. For compliant surfaces, such as elastomeric films, skin-surface  
25 (closed-cell) foams, soft films, pressure would be applied, as a result of a weighted backing,  
latching or gripping devices for holding the film against the collars, a vacuum chuck which  
holds the film in position and can release the film, as appropriate, etc. The film may be stretched  
across the collars, held in position by clasps at the periphery of the substrate, a sealing pliable  
band around the periphery, a vacuum chuck, etc. A continuous sealing film may be used, which  
30 may be unrolled from a reel as the devices are moved in a continuous manner, for example, on a  
wheel or moving belt. The films may be natural rubber, polyisoprene, ethylene-propylene



elastomers, polyurethane foams, polydimethylsiloxane, etc. The films may be thin or thick, so long as they have a minimum dimension, which provides for their sealing of the collars.

Generally, the films will be at least about  $50\mu$  in thickness. Alternatively, films may be used, which have a thin adherent layer, which will adhere to the surface of the collar and after the film has fulfilled its function, the adhesive may be removed. Useful adhesives include pressure sensitive adhesives, such as ethylene-containing polymers, urethane polymers, butyl rubber, butadiene-acrylonitrile polymers, butadiene-acrylonitrile-isoprene polymers, and the like. See, for example, U.S. Patent no. 5,908,695 and references cited therein.

The substrate will generally have a thickness of at least about  $20\mu\text{m}$ , more usually at least about  $40\mu\text{m}$ , and not more than about  $0.5\text{cm}$ , usually not more than about  $0.25\text{cm}$ . The width of the substrate will be determined by the number of units to be accommodated and may be as small as about  $2\text{mm}$  and up to about  $6\text{cm}$  or more. The dimension in the other direction will generally be at least about  $0.5\text{cm}$  and not more than about  $20\text{cm}$ , usually not more than about  $10\text{cm}$ . The substrate may be a flexible film or relatively inflexible solid, where the microstructures, such as reservoirs and channels, may be provided by embossing, molding, machining, etc. The collars may be formed at the same time using the same process, although more expensive processes may be used, such as photolithography or laser ablation. In this case, the collar regions would be protected while the substrate was eroded. The channel dimensions will generally be in the range of about  $0.1\mu\text{m}$  to  $1\text{mm}$  deep and about  $0.5\mu\text{m}$  to  $500\mu\text{m}$  wide, where the cross-section will generally be  $0.1\mu\text{m}^2$  to about  $0.25\text{mm}^2$ . The channel lengths will vary widely depending on the operation for which the channel is to be used, generally being in the range of about  $0.05\text{mm}$  to  $10\text{cm}$ , more usually in the range of about  $0.5\text{mm}$  to  $1\text{cm}$ . The reservoirs will generally have volumes in the range of about  $10\text{nl}$  to  $10\mu\text{l}$ , more usually have volumes in the range of about  $20\text{nl}$  to  $1\mu\text{l}$ . The reservoirs may be cylindrically shaped or conically shaped, particularly inverted cones, where the diameter of the port will be from about 1.5 to 25 times, usually 1.5 to 15 times, the diameter of the bottom of the reservoir, where the reservoir connects to the channel.

Depending upon whether a film is embossed to produce the device or the device is molded, whether the microfeatures are left open will depend upon whether a supporting film and/or an enclosing film is provided. The supporting film will generally be at least about  $40\mu\text{m}$  and not more than about  $5\text{mm}$  thick. The film used to enclose the channels and the bottom of

the reservoirs will generally have a thickness in the range of about 10 $\mu$ m to 2mm, more usually in the range of about 20 $\mu$ m to 1mm. The selected thickness is primarily one of convenience and assurance of good sealing and the manner in which the devices will be used to accommodate instrumentation. Therefore, the ranges are not critical.

5 The collars surrounding the reservoir ports will generally have a height from the planar surface of the substrate in the range of about 0.1 to 1mm, more usually about 0.2 to 1mm, and preferably about 0.25 to 0.75mm. The crown will be thick enough to provide a good seal between the sealing film or lid and the crown, so that usually it will be about 0.05 to 1mm thick, more usually about 0.1 to about 0.5mm thick. The collars may be considered extensions of the  
10 inner walls of the microstructures, having an inner wall aligned with the inner wall of the microstructure, where the collars then extend outwardly from the inner wall, much like the structure of a volcano. Alternatively, the collar inner wall may be displaced from the reservoir inner wall, generally displaced less than about 1mm, usually less than about 0.5mm and may be less than about 0.1mm. In this way the inner wall is offset from the edge of the reservoir,  
15 serving as a fence around the reservoir.

The area occupied by a single unit will vary widely, depending on the number of units of the device, the function of the units, and the like. As illustrative, for the most part, where the devices are designed to be compatible with 96 to 384 microtiter well plates, the units will have from about 4.5 to 9mm spacings.

20 As indicated, the substrate may be a flexible film or inflexible solid, so the method of fabrication will vary with the nature of the substrate. For embossing, at least two films will be used, where the films may be drawn from rolls, one film embossed and the other film adhered to the embossed film to provide a physical support. The individual units may be scored, so as to be capable of being used separately, or the roll of devices retained intact. See, for example,  
25 application serial no. PCT/98/21869. Where the devices are fabricated individually, they will usually be molded, using conventional molding techniques. The substrates and accompanying film will generally be plastic, particularly organic polymers, where the polymers include addition polymers, such as acrylates, methacrylates, polyolefins, polystyrene, etc. or condensation polymers, such as polyethers, polyesters, polyamides, polyimides, etc. Desirably,  
30 the polymers will have low fluorescence inherently or can be made so by additives or bleaching. The underlying enclosing film will then be adhered to a substrate by any convenient means, such

as thermal bonding, adhesives, etc. The literature has many examples of adhering such films, see, for example, U.S. Patent nos. 4,558,333; and 5,500,071.

Liquids may be moved through the units by any convenient means, including electrokinesis, pneumatics, sonics, thermal, etc. Electrokinetic devices will usually have two or more reservoirs connected by microchannels, where the microchannels may cross, providing for injection of a plug from one microchannel into another microchannel. The devices may find use in sequencing of nucleic acids, detection of binding between two entities, e.g. proteins with proteins, small molecules or cells, or various assays for the determination of drugs, single nucleotide polymorphisms, etc.

The methods employing the subject devices may be associated with the transfer to the microstructures of the devices of volumes ranging from about 10nl to 500 $\mu$ l, with reaction volumes ranging from about 20nl to 0.5ml, usually 50nl to 0.1ml. The volumes may be transferred by any efficient means, including pins, ink-jet dispensers, other piezoelectric devices, pipettes, etc. After the liquid is dispensed, the applicable seal may be applied. Instead of dispensing liquid into the microstructure, the process may involve withdrawing liquid from the microstructure. Where the seal is in place, the seal would be removed, the liquid withdrawn from the microstructure and the seal replaced. In this way the integrity of the concentration of the solution in the microstructure may be maintained. Alternatively, one may have a self-sealing film, where the seal would be pierced for the transfer of liquid.

For further understanding of the invention, the drawings will now be considered. In Fig. 1 is depicted a plan view of a microfluidic device having 96 units with the spacing appropriate to a 96 well microtiter plate, where the spacing of the collars is shown. The device 100 has a substrate 102 with collars 104 associated with the reservoirs 106. In Fig. 1a, a cross-sectional view is shown of the device 100. The device 100 is shown with reservoirs 106, only two reservoirs being shown for clarity. Above the reservoirs 106 on the upper planar surface 108 of the device are collars 104. An enclosing film 110 provides the bottom of the device, serving to enclose the reservoirs 106 and channels 112.

In Fig. 2, the device 150 is shown with the sealing film removed to provide the detail of the individual microfluidic units 152. An expanded version of the microfluidic units 152 is depicted in a diagrammatic plan view in Fig. 2a. This unit is for illustration purposes only and demonstrates a unit for performing a reaction with incubation, followed by separating the

components of the reaction mixture using electrophoresis and identifying the product with a detector, not shown. The unit 152 has a separation channel 154, beginning with electrophoresis buffer reservoir 156 and terminating in waste reservoir 158. The assay channel 160 begins with a reagent incubation reservoir 162 and ends with a second waste reservoir 164. The reagent incubation reservoir 162 receives the various components of the reaction where the reagents may react. Some of the liquid in the reagent incubation reservoir 162 may wick by capillary action through the separation channel to a stop-junction reservoir 168 provided in assay channel 160 to stop the movement of the reaction solution. After sufficient time for incubation liquid remaining in the reagent incubation reservoir 162 is moved by pressure to the stop-junction reservoir 168 and the electrophoretic process begun by introducing electrodes into the waste reservoirs 158 and 164, the stop-junction reservoir 168 and the buffer reservoir 156. By activating the electrodes in the stop-junction reservoir 168 and the waste reservoir 164, the reaction components may be moved to cross-section 166 for injection into separation channel 154. The electrodes in the reservoirs 164 and 168 may then be allowed to float, while the electrodes in buffer reservoir 156 and waste reservoir 158 are activated for electrophoretic transport and separation in separation channel 154 for detection of product.

In Fig. 3 is shown a cross-section of a reservoir with the collar on a substrate. The substrate 200 has an upper planar surface 202. Extending upward from upper planar surface 202 is the external wall of collar 204. As shown in the Figure, the collar 204 meets with the upper opening 206 of reservoir 208. The wall 210 of reservoir 208 is shown as conical having a linearly even surface, but could be vertical or irregular, as needed. The reservoir wall 210 is aligned with the collar wall 204, having a smooth transition, being a single feature when molding the substrate. As already indicated, the collar inner wall may be offset from the port edge. The reservoir 208 terminates at the bottom into channel 212. The channel 212 is enclosed by film 214, which adheres to the bottom surface 216 of the substrate. The reservoir 208 is enclosed by a conformable cover film 218, backed by a weighted backing 220, to hold the film 218 in sealing relationship with the top surface 222 of collar 204.

The subject invention provides many advantages in enclosing, usually reversibly, small reservoirs or other microstructure. The subject collar structure has a small contact area, which serves to concentrate the force produced by whatever means of application of the lid onto a much smaller area, as compared to a cover which bonds to the entire surface of the device. A

reduction in differential pressures created during application of the lid is achieved. Where the upper surface is flat, without areas in relief, a conformal lid comes down in such a way that it will usually first make contact with a large ring around the area to be sealed. The air trapped within this ring is pressurized into the volume to be sealed. By contrast with the subject

5 structure, the lid makes contact before it reaches the device main surface, avoiding trapping large volumes of air. In addition, for lid attachment mechanisms like gravity, friction and mechanical clips, where the force is not directly related to the contact area, the subject method increases the local pressure with which the lid is attached to the part. This increased pressure generally improves the seal and improves the proximity of conformal lids. This improved seal can enable

10 the use of a weighted lid to produce an airtight seal without requiring a large mass or an extremely conformable lid material. Where the seal is substantially air tight, the lid will act to resist or prevent fluid flow. Capillary stop junctions may be prone to failure by condensation or other mechanism, in which case the sealed lid provides a backup mechanism. Also, the sealed lid can easily counteract relatively strong fluidic forces, such as surface tension. Yet another

15 advantage of the collar is that the effective leakage path (surface path) between two adjacent wells is increased. This increases the resistance to arcing due to high differential voltages in two adjacent wells. In fact, multiple concentric collars would be beneficial in further reducing this problem. Finally, during application and removal of a lid, there is a potential for liquids to wick between the lid and the surface of the device and microstructures. The short distance between

20 the device and the lid can result in very strong capillary pressures. In the subject invention the lid is only in close proximity to the collar surface, so that fluid can only wick along that surface. By avoiding continuous ridges between different microstructures, movement of liquid between the microstructures can be obviated.

All publications and patent applications mentioned in this specification are indicative of

25 the level of skill of those skilled in the art to which this invention pertains. All publications and patent applications are herein incorporated by reference to the same extent as if each individual publication or patent application was specifically and individually indicated to be incorporate by reference.

The invention now having been fully described, it will be apparent to one of ordinary

30 skill in the art that many changes and modifications can be made thereto without departing from the spirit or scope of the appended claims.

## WHAT IS CLAIMED IS:

1. A microfluidic device comprising a substrate having a planar surface, a plurality of openings in said surface of microstructures and at least a portion of said openings surrounded by a collar in relief.
2. A microfluidic device according to Claim 1, wherein said collar has its inner surface aligned with the inner surface of said opening and a thickness of from about 0.05 to 0.5mm thick extending away from said inner surface.
3. A microfluidic device according to Claim 2 wherein said collar is covered with a lid of a conformable material.
4. A microfluidic device according to Claim 2, wherein said collar is covered with a lid with an adhesive coating.
5. A microfluidic device according to Claim 1 produced by plastic molding.
6. A microfluidic device comprising a substrate having a planar surface, a plurality of reservoirs having openings in said surface, said reservoirs having volumes in the range of about 10nl to 10 $\mu$ l and at least a portion of said openings surrounded by a collar in relief, having an inner surface aligned with the inner surface of said reservoir, said collar having a height in the range of about 0.1 to 1mm and thickness of from about 0.05 to 0.5mm thick extending away from said inner surface.
7. A microfluidic device according to Claim 6, where at least a portion of said reservoirs are connected to one or more other reservoirs by microchannels.
8. A microfluidic device according to Claim 6, wherein at least a portion of said reservoirs are positioned in accordance with a 96, 384 or 1536 microtiter well format.
9. A microfluidic device according to Claim 6, wherein said collar is covered with a lid.
10. A microfluidic device according to Claim 9, wherein each collar is covered with a lid, which lid is a portion of a continuous film.
11. A microfluidic device according to Claim 6, wherein said substrate comprises an acrylic polymer and is molded.
12. In a method employing a microfluidic device comprising introducing small volumes into microstructures, where the volumes comprise volatile solvents, the improvement which

comprises: introducing said small volumes into a device according to Claim 1; and  
applying a compliant or adhesive lead to each of said collars.

13. A method according to Claim 12, wherein said lid is a portion of a continuous film.
14. A method according to Claim 12, wherein said microstructures are components of an  
electrokinetic device.

5

DOCKET # 2008030000

## EFFICIENT MICROFLUIDIC SEALING

## ABSTRACT OF THE DISCLOSURE

Improved sealing for microstructures in microfluidic devices having a plurality of units is provided by providing collars surrounding the openings to the microstructures, such as reservoirs. The collars are protrusions extending from the surface of the devices and the internal walls of the collars generally aligned with the internal walls of the microstructure. Conformable and/or adhesive lids are employed for sealing the microstructures.



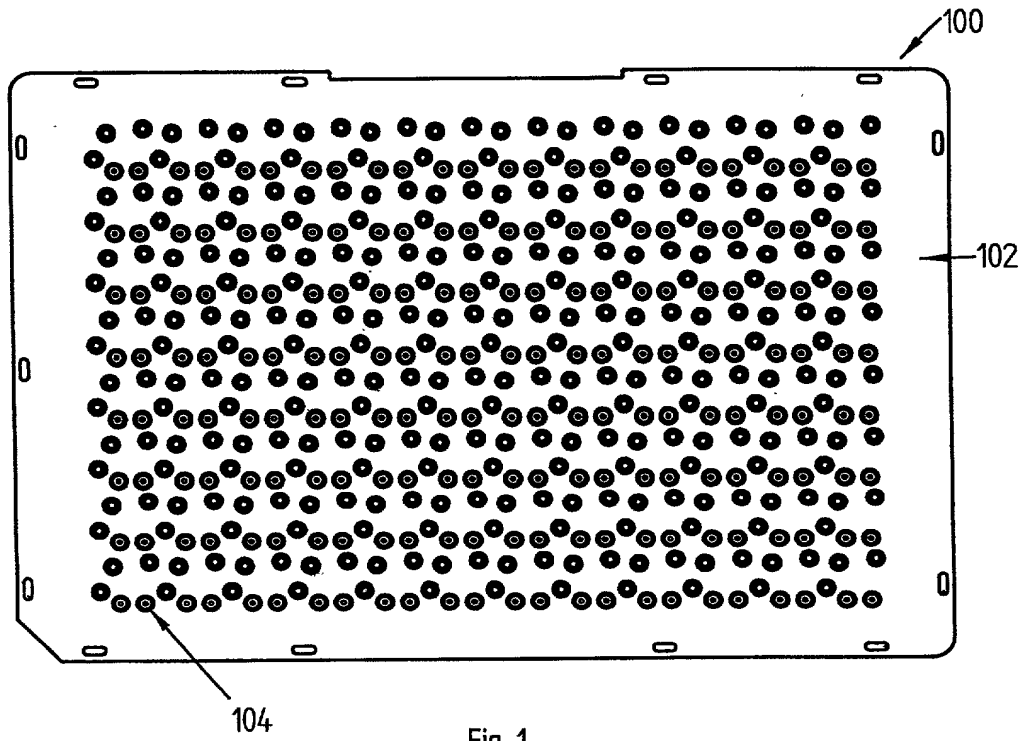


Fig. 1

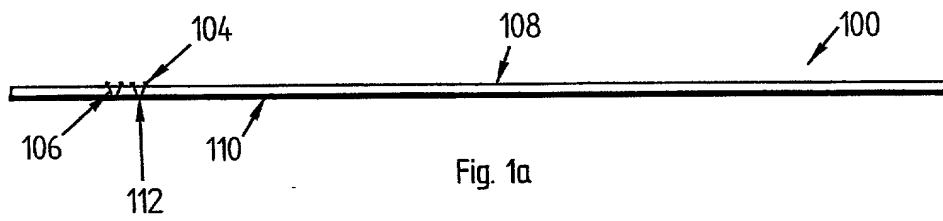


Fig. 1a

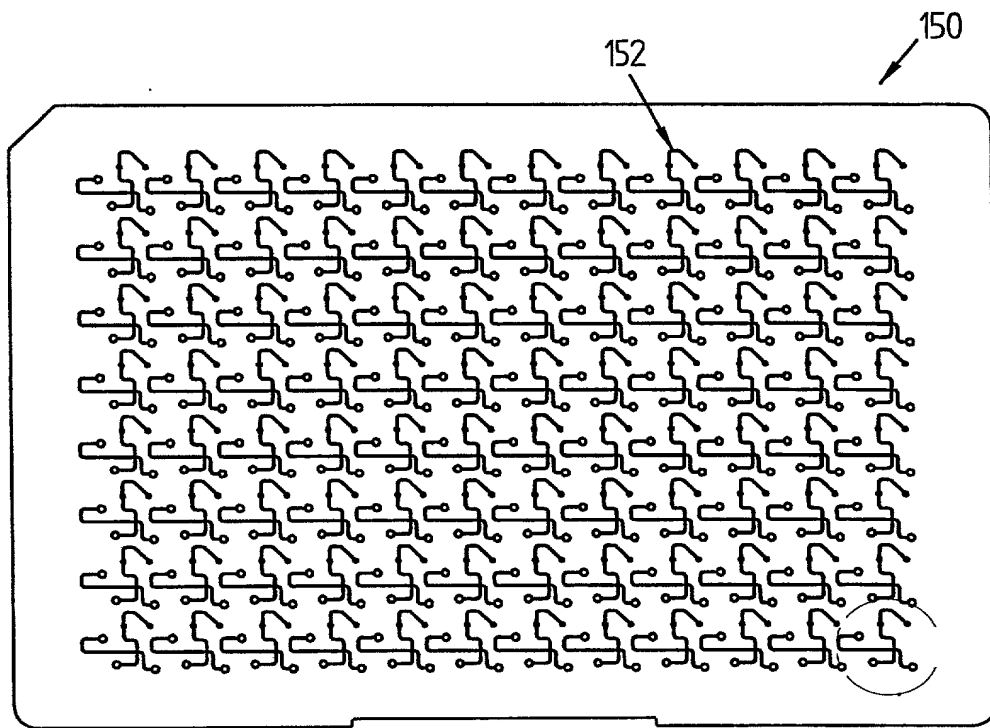


Fig. 2

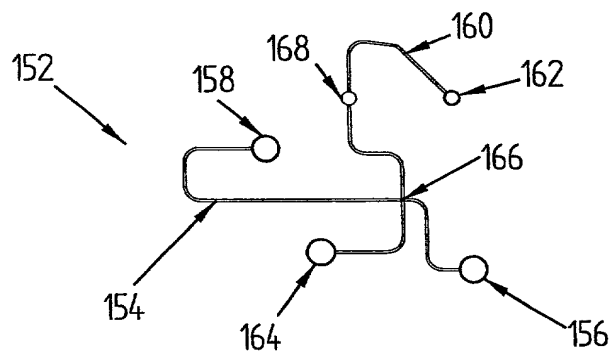


Fig. 2a

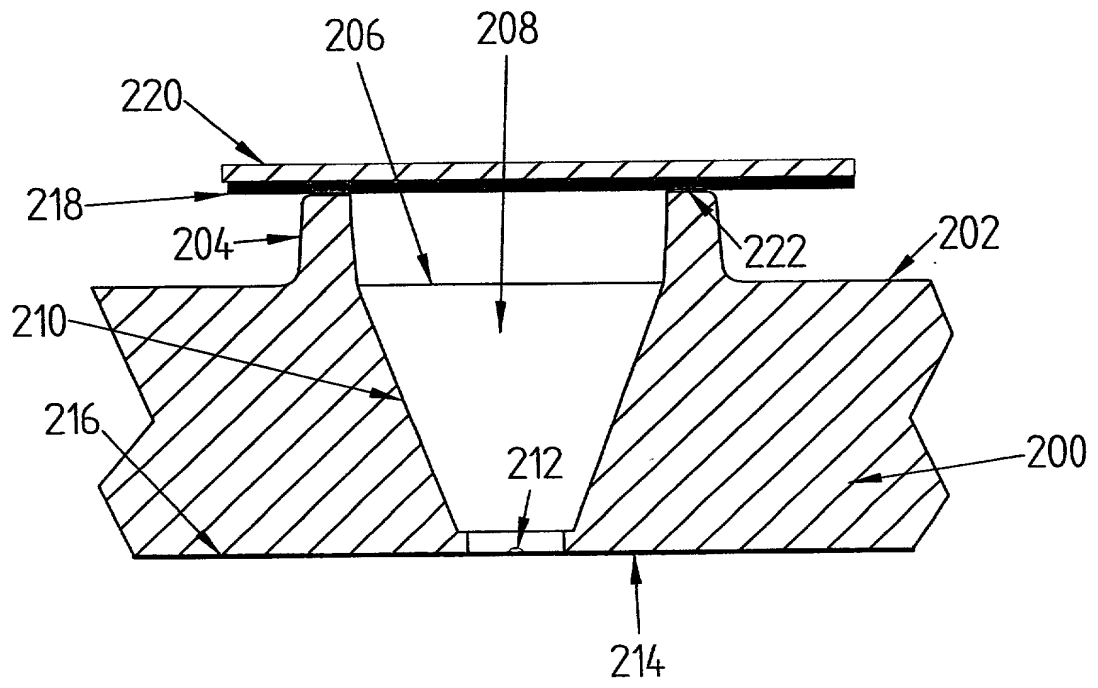


Fig. 3

**COMBINED INVENTOR  
DECLARATION AND POWER OF ATTORNEY**

As a below-named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name, I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

**Efficient microfluidic sealing**

the specification of which

(check one) ☐ Is attached hereto.  
☐ Was filed on and has been assigned Serial Number .  
☒ Was filed on October 18, 2000 as Attorney Docket No. ACBI.049.00US.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose all information known to me to be material to patentability of this application as defined in Title 37, Code of Federal Regulations, §1.56 and, if applicable, all such information under 37 CFR § 1.56 which became available between the national or PCT International filing date of the prior application and the filing date of this application.

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)

Priority Claimed

(number)	(Country)	(Day/Month/Year Filed)	<input type="checkbox"/> Yes	<input type="checkbox"/> No
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Prior Foreign Application(s)

Priority Claimed

(number)	(Country)	(Day/Month/Year Filed)	<input type="checkbox"/> Yes	<input type="checkbox"/> No
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Prior Foreign Application(s)

Priority Claimed

(number)	(Country)	(Day/Month/Year Filed)	<input type="checkbox"/> Yes	<input type="checkbox"/> No
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I hereby claim the benefit under Title 35, United States Code, §119(e) of any provisional application and §120 of any non-provisional United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of 35 USC §112 I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, §1.56, which became available between the filing date of the prior application and the national or PCT international filing date of this application:

09/545,064	10/22/99	Pending
(Application Serial No.)	(Filing Date)	(Status)

(Application Serial No.)	(Filing Date)	(Status)
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(Application Serial No.)	(Filing Date)	(Status)
* designating the U.S.		

I hereby appoint:

BARBARA RAE-VENTER, Ph.D., Reg. No. 32,750  
BERTRAM I. ROWLAND, Ph.D., Reg. No. 20,015  
JENNIFER WAHLSTEN, Ph.D., Reg. No. 46,226

as my attorneys or agents with full power of substitution and revocation to prosecute my above-identified application for Letters Patent and to transact all business in the Patent Office connected therewith.

Direct all telephone calls to Barbara Rae-Venter, Ph.D. at (650) 328-4400.

Address all correspondence to:

Bertram I. Rowland  
Rae-Venter Law Group, P.C.  
P. O. Box 60039  
Palo Alto, California 94306-0039

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Title 18, United States Code, §1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full name of sole or first inventor: Sam Schaevitz

Inventor's signature: \_\_\_\_\_

Date: \_\_\_\_\_

Residence: MIT, 3 Ames Street Box 314 Cambridge, MA 02139

Citizenship: \_\_\_\_\_

Post Office Address: Same

Full name of second joint inventor, if any: Travis Boone

Inventor's signature: \_\_\_\_\_

Date: \_\_\_\_\_

Residence: 765 San Antonio Rd. #25 Palo Alto, CA 94303

Citizenship: USA

Post Office Address: Same

Full name of third joint inventor, if any: Torleif Ove Bjornson

Inventor's signature: \_\_\_\_\_

Date: \_\_\_\_\_

Residence: 7030 Daniel Court Gilroy, California 95020

Citizenship: Sweden

Post Office Address: Same